

**OROVILLE FERC RELICENSING
(PROJECT No. 2100)**


**INTERIM REPORT
SP-F3.2 TASK 2
SP-F21 TASK 1**

**APPENDIX A
MATRIX OF LIFE HISTORY AND HABITAT REQUIREMENTS FOR
FEATHER RIVER FISH SPECIES**

**LITERATURE REVIEW OF LIFE HISTORY AND
HABITAT REQUIREMENTS FOR
FEATHER RIVER FISH SPECIES**

RIVER LAMPREY

JANUARY 2003

Element	Element Descriptor	General	Feather River Specific
General			
common name (s)	English name (usually used by fishers and laypeople).	River lamprey	
scientific name (s)	Latin name (referenced in scientific publications).	<i>Lampetra ayresi</i>	
taxonomy (family)	Common name of the family to which they belong. Also indicate scientific family name.	Lampreys – <i>Petromyzontidae</i> Specialized aquatic vertebrates, eel-like in form but lacking the jaws and paired fins of true fishes. They are distantly allied to the long-extinct ostracoderms, among the earliest known vertebrates (Moyle 2002).	
depiction	Illustration, drawing or photograph.		
range	Broad geographic distribution, specifying California distribution, as available.	From Juneau, Alaska to San Francisco Bay. British Columbia, where they are most abundant, is the center of the range. In California, most records are for the lower Sacramento-San Joaquin River system (Moyle 2002).	
native or introduced	If introduced, indicate timing, location, and methods.	Native (Moyle 2002).	

Element	Element Descriptor	General	Feather River Specific
ESA listing status	Following the categories according to California Code of Regulations and the Federal Register, indicate whether: SE = State-listed Endangered; ST = State-listed Threatened; FE = Federally listed Endangered; FT = Federally-listed Threatened; SCE = State Candidate (Endangered); SCT = State candidate (Threatened); FPE = Federally proposed (Endangered); FPT = Federally proposed (Threatened); FPD = Federally proposed (Delisting); the date of listing; or N = not listed.	Not listed.	
species status	If native, whether: Extinct/extirpated; Threatened or Endangered; Special concern; Watch list; Stable or increasing. If introduced, whether: Extirpated (failed introduction); highly localized; Localized; Widespread and stable; Widespread and expanding.	River lamprey is on the Watch List (Moyle 2002). Trends in California populations are unknown, but are likely to have suffered a considerable decline due to the decline of suitable spawning and rearing habitat in the lower reaches of larger rivers. They are easily overlooked, so they may be more abundant than as indicated. There are few records of river lamprey in California (Moyle 2002).	
economic or recreational value	Indicate whether target species sought for food or trophy. Whether desirable by recreational fishers, commercial fishers, or both.	No economic and recreational value.	
warmwater or coldwater	Warmwater if suitable temperature range is similar to basses; coldwater if suitable temperature range is similar to salmonids.		

Element	Element Descriptor	General	Feather River Specific
pelagic or littoral	Environment: Pelagic - living far from shore; Littoral - living near the shore.		
bottom or water column distribution	Environment: bottom (benthic) or along water column.	Adults are free-swimming within the water column (Wang J. 1986).	
lentic or lotic	Environment: Lentic - pertaining to stagnant water, or lake-like; Lotic - moving water, or river-like.		
Adults			
life span	Approximate maximum age obtained.	The maximum age of river lamprey is likely 6 to 7 years (Moyle 2002). Death occurs approximately 2 years following the onset of metamorphosis, just after spawning. (Beamish R.J. 1980).	
adult length	Indicate: Length at which they first reproduce; average length and maximum length the fish can attain.	The average size of spawning river lamprey is 6.7 inches (17 cm) TL. The maximum length of river lamprey is approximately 12.2 inches (31 cm) TL (Moyle 2002). In British Columbia, adults range in length from 4.7 to 9.4 inches (12-24 cm) (Beamish R.J. et al. 1987).	
adult weight	Indicate: Weight at which they first reproduce; average weight and maximum weight the fish can attain.		
physical morphology	General shape of the fish: elongated, fusiform, laterally compressed, etc.	River lamprey are elongated and eel-like in appearance.	
coloration	Indicate color, and color changes, if any, during reproduction phase.	Adult river lamprey are dark on the back and sides and silvery to yellow ventrally (Moyle 2002).	
other physical adult descriptors	Unique physical features for easy identification.		
adult food base	Indicate primary diet components.	River lamprey feed on a variety of fishes 3.9–11.8 inches (10-30 cm) TL, most commonly herring and salmon (Beamish R.J. et al. 1987; Moyle 2002).	

Element	Element Descriptor	General	Feather River Specific
adult feeding habits	Indicate whether plankton eater, algae eater, bottom feeder, piscivorous, active hunter, ambush predator, filter feeder. Night, day, dusk or dawn feeder.	<p>River lamprey are piscivorous and predaceous. They attach to the back of host fish, above the lateral line, and feed on muscle tissue. Feeding continues even after the death of the prey (Moyle 2002).</p> <p>More than one lamprey may feed on a single salmon. Predation by river lamprey is an important source of direct and indirect mortality to salmon and herring (Beamish R.J. et al. 1987).</p> <p>River lamprey are considered more of a predator than a parasite because they feed by removing flesh from the host and killing them. Feeding continues after the death of the host (Beamish R.J. 1980; Beamish R.J. et al. 1995).</p>	
adult in-ocean residence time	For anadromous species, age when they migrate to the ocean and duration spent in the ocean before returning to freshwater to spawn.	<p>After a 9-month (in-river) metamorphosis, and acclimation at sea (in estuaries and salinity wedges of rivers and streams), river lamprey spend approximately 3 months in the ocean (Beamish R.J. et al. 1987).</p> <p>River lamprey ammocoetes are likely to be from 3 to 5 years old when they begin the transformation into adults (Moyle 2002).</p> <p>River lamprey remain in saltwater from 3 to 4 months (in contrast to Pacific lamprey, which spend approximately 3.5 years in saltwater) (Beamish R.J. 1980; Moyle 2002).</p>	
adult habitat characteristics in-ocean	For anadromous species, description of the ocean habitat utilized: whether along major current systems, gyres, pelagic (beyond continental shelves) and neritic (above continental shelves) zones, etc.		
Adult upstream migration (immigration)			
range of adult upstream migration timing	Time of year adults migrate upstream. If applicable, indicate for various runs.	Based on studies of river lamprey in British Columbia, adult upstream migration occurs in autumn. The range and more exact timing of upstream migration of adults is unknown (Moyle 2002).	

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		<p>In British Columbia, river lamprey return to freshwater between September and May (Wang J. 1986).</p> <p>Some adult river lamprey return to freshwater as early as July (Beamish R.J. et al. 1987).</p> <p>Between September and late winter, river lamprey return to freshwater (Beamish R.J. 1980).</p>	
peak adult upstream migration timing	Time of year most adults migrate upstream. If applicable, indicate for various runs.		
adult upstream migration water temperature tolerance	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
adult upstream migration water temperature preference	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental.		
Adult holding (freshwater residence)			
water temperature tolerance for holding adults	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
water temperature preference for holding adults	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental.		
water depth range for holding adults	Reported range of observed (minimum and maximum) water depth utilization.		
water depth preference for holding adults	Reported range of most frequently observed water depth utilization.		

Element	Element Descriptor	General	Feather River Specific
substrate preference for holding adults	If bottom dwellers, indicate substrate: mud, sand, gravel, boulders, aquatic plant beds, etc. If gravel, indicate range or average size of gravel.		
water velocity range for holding adults	Reported range of observed (minimum and maximum) water velocity utilization.		
water velocity preference for holding adults	Reported range of most frequently observed water velocity utilization.		
other habitat characteristics for holding adults	General description of habitat (e.g. turbid or clear waters, lentic or lotic, presence of aquatic plant beds, debris, cover, etc.).		
timing range for adult holding	Time of year (earliest-latest) and duration of stay from upstream migration to spawning.	River lamprey remain in freshwater from autumn (when they enter freshwater) until the period of February through May, when spawning occurs (Moyle 2002). River lamprey hold in freshwater for up to 8 months, from the time they enter freshwater (September through late winter) until spawning (April through June) (Beamish R.J. 1980).	
timing peak for adult holding	Time of year when maximum number of adults are present before spawning.		
Spawning			
fecundity	Average or range in the number of eggs females lay in a spawning season.	Fecundity estimates are limited. One female [6.9 inches (17.5 cm) TL] from Cache Creek contained approximately 37,300 eggs; another female [9.1 inches (23 cm TL)] contained approximately 11,400 eggs (Moyle 2002; Wang J. 1986).	
nest construction	Location and general description of nest -- substrates, aquatic plants, excavations, crevices, habitat types, etc.	In the laboratory, river lamprey constructed nests approximately 5.9 inches (15 cm) in diameter in gravel (unknown gravel size class) (Beamish R.J. et al. 1995).	

Element	Element Descriptor	General	Feather River Specific
nest size	Size and average dimensions of the nest.		
spawning process	Indicate whether nest builder, broadcast spawner, or other.		
spawning substrate size/characteristics	Range of substrates used during spawning (e.g. mud, sand, gravel, boulders, beds of aquatic plants). Indicate presence of plant/wood debris, crevices at spawning sites. If gravel, indicate range of average size.	River lamprey construct nests in rocks and gravel (Wang J. 1986). Adult river lamprey construct “ <i>saucer-shaped depressions</i> ” in gravelly riffles (Moyle 2002).	
preferred spawning substrate	Indicate preferred spawning substrate (e.g. mud, sand, gravel, boulders, plant bed, etc).		
water temperature tolerance for spawning	Range of water temperatures allowing survival. Indicate stressful or lethal levels.	In a laboratory study, river lamprey spawned in holding tanks during May when the water temperature was 53.6°F (12°C) (Beamish R.J. et al. 1995). River lamprey are reported to spawn at water temperatures of 55.4°F to 56.3°F (13.0°C–13.5°C) (Wang J. 1986).	
water temperature preference for spawning	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.		
water velocity range for spawning	Minimum and maximum speed of water current the spawning fish can tolerate.		
water velocity preference for spawning	Preferred water current (flow velocity) during spawning.		
water depth range for spawning	Reported range of observed (minimum and maximum) water		

Element	Element Descriptor	General	Feather River Specific
	depth utilization.		
water depth preference for spawning	Reported range of most frequently observed water depth utilization.		
range for spawning timing	Earliest and latest time of season or year in which spawning occurs.	<p>River lamprey spawning occurs from February through May in British Columbia (Moyle 2002).</p> <p>River lamprey spawning occurs from April through May (Wang J. 1986).</p> <p>In British Columbia, spawning occurs from April through June (Beamish R.J. 1980).</p>	
peak spawning timing	Time of year most fish start to spawn.	Peak river lamprey spawning occurs in May in British Columbia (Beamish R.J. 1980).	
spawning frequency (iteroparous/semelparous)	<p>Semelparous - producing all offspring at one time, such as in most salmon. Usually these fish die after reproduction.</p> <p>Iteroparous-producing offspring in successive, e.g., annual or seasonal batches, as is the case in most fishes.</p>	River lamprey are semelparous, and die after spawning (Moyle 2002).	
Incubation/ early development			
egg characteristics	Shape, size, color, in clusters or individuals, stickiness, and other physical attributes.	River lamprey eggs are reported to be 0.02 inches (0.7 mm) in diameter (Wang J. 1986).	
water temperature tolerance for incubation	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
water temperature preference for incubation	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.		

Element	Element Descriptor	General	Feather River Specific
time required for incubation	Time duration from fertilization to hatching. Note: Indicate at which temperature range. Incubation time is temperature-dependent.		
size of newly hatched larvae	Average size of newly hatched larvae.		
time newly hatched larvae remain in gravel	Time of year of hatching, and duration between hatching and emergence from gravel.		
other characteristics of larvae	Alevin -- early life history phase just after hatching (larva) when yolk-sac still present.		
timing range for emergence	Time of year (earliest-latest) hatchlings (larvae and alevins) leave or emerge from the nesting/hatching (gravel) sites.		
timing peak for emergence	Time of year most hatchlings emerge.		
size at emergence from gravel	Average size of hatchlings at time of emergence.		
Juvenile rearing			
general rearing habitat and strategies	General description of freshwater environment and rearing behavior.	River lamprey ammocoetes burrow into sandy or muddy substrates near the bank (Wang J. 1986).	
water temperature tolerance for juvenile rearing	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
water temperature preference for juvenile rearing	Range of suitable, preferred, or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.		

Element	Element Descriptor	General	Feather River Specific
water velocity ranges for rearing juveniles	Reported range of observed (minimum and maximum) water velocity utilization.		
water velocities preferred by rearing juveniles	Reported range of most frequently observed water velocity utilization.		
water depth range for juvenile rearing	Reported range of observed (minimum and maximum) water depth utilization.		
water depth preference for juvenile rearing	Reported range of most frequently observed water depth utilization.		
cover preferences for rearing juveniles	Type of cover for protection from predators used by rearing juveniles (e.g. crevices, submerged aquatic vegetation, overhanging vegetation, substrate cover, undercover bank, small woody debris, large woody debris).	River lamprey ammocoetes burrow into sandy or muddy substrates near the bank (Wang J. 1986). River lamprey ammocoetes remain in silty backwaters and eddies (Moyle 2002).	
food base of juveniles	Indicate primary diet components. Also indicate the diet changes, if any, as growth occurs.	Ammocoetes feed on algae and microorganisms (Moyle 2002). River lamprey ammocoetes have no teeth, and feed on microscopic plants and animals (Wang J. 1986).	
feeding habits of rearing juveniles	Indicate whether plankton eater, algae eater, bottom feeder, piscivorous, active hunter, ambush predator, filter feeder. Night, day, dusk or dawn feeder. Also indicate change of feeding habits growth occurs.		
predation of juveniles	Indicate which species prey on juveniles.		
timing range for juvenile rearing	Range of time of year (months) during which rearing occurs.	The river lamprey ammocoete lifestage likely lasts from 3 to 5 years (Moyle 2002). The transformation from ammocoete into adult begins when ammocoetes are approximately 4.7 inches TL (12 cm TL).	

Element	Element Descriptor	General	Feather River Specific
		<p>Metamorphosis takes 9-10 months and begins during the summer (Moyle 2002).</p> <p>Metamorphosis from ammocoetes to juveniles and young adults (when the oesophagus opens) begins in July and is completed by April of the following year; in total, metamorphosis takes approximately 9 months (Beamish R.J. 1980; Beamish R.J. et al. 1987).</p>	
timing peak for juvenile rearing	Time of year (months) during which most rearing occurs.		
Juvenile emigration			
time spent in fresh water prior to emigrating	Duration (in years and/or months) from emergence to emigration to the ocean.		
water temperature tolerances during emigration	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
water temperature preferences during emigration	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.		
emigration timing range	Time of year juveniles commence emigration and duration of emigration	<p>River lamprey congregate upriver from saltwater for 4 months as young adults and rapidly grow to 9.8–12.2 inches (25-31 cm) TL, and enter the ocean in late spring (Moyle 2002).</p> <p>River lamprey migrate to the ocean from May through July (Beamish R.J. 1980).</p> <p>Immature adult river lamprey enter saltwater from May through July and feed voraciously on herring and salmon, growing from 4.7 inches (12 cm), [0.07 ounces (2g)] to 9.8 inches (25 cm), [0.71 ounces (20g)]. River lamprey continue feeding until mid-September (Beamish R.J. 1980; Beamish R.J. et al. 1987).</p>	
emigration timing peak	Time of year most juveniles are emigrating.	River lamprey salinity acclimation and feeding peaks in June (Beamish R.J. et al. 1987).	

Element	Element Descriptor	General	Feather River Specific
size range of juveniles during emigration	Minimum and maximum sizes (inches or mm) of emigrating juveniles. Indicate average size.	Mean length of immature adult river lamprey entering saltwater is 4.3 inches (11 cm) (Beamish R.J. 1980; Beamish R.J. et al. 1987).	
factors associated with emigration	Pulse flows, water temperature changes, turbidity levels, photoperiod, etc.	The metamorphosis from ammocoete to adult is strongly correlated to river discharge. Delay of metamorphosis in autumn is associated with declining river discharge. During the spring, when river discharge is at a maximum, the ability to osmoregulate is increased, and metamorphosis nears completion (based on laboratory trials). Based on these observations, it is hypothesized that river lamprey have evolved in response to the discharge patterns of rivers (Beamish R.J. et al. 1987).	
Other potential factors			
DO	Levels of dissolved oxygen in water expressed in mg/l tolerated by fish (lower limits)		
pH	Alkalinity/acidity of water (expressed in pH) that fish can tolerate		
turbidity	Indicate: level or turbidity or state of water (e.g., clear water or presence of siltation or organic/inorganic matter in water) that fish can tolerate		
factors contributing to mortality	e.g. fishing/angling mortality, drastic habitat alterations, unfavorable climatic changes, etc.		

References

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- Beamish R.J. and Youson J.H. 1987. Life History and Abundance of Young Adult *Lampetra ayresi* in the Fraser River and Their Possible Impact on Salmon and Herring Stocks in the Strait of Georgia. Can.J.Fish.Aquat.Sci. 44:525-537.
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